Small Business Innovation Research/Small Business Tech Transfer

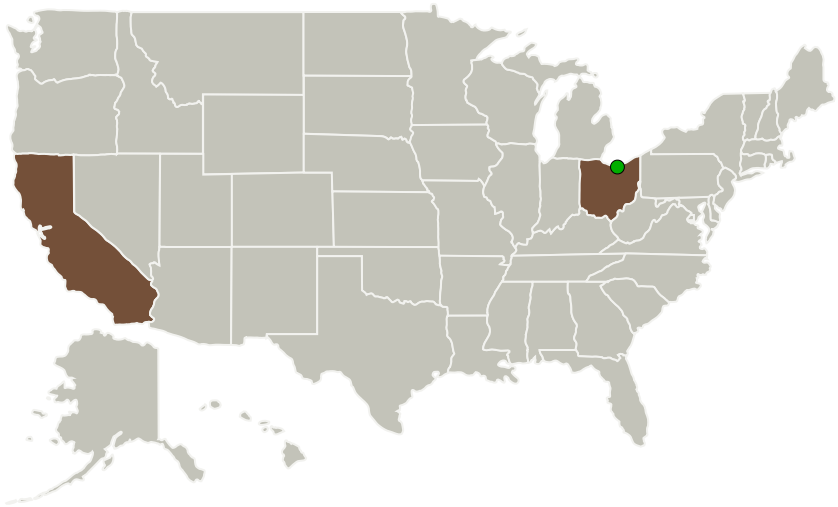
Parahydrogen-Orthohydrogen Catalytic Conversion for Cryogenic Propellant Passive Heat Shielding, Phase I

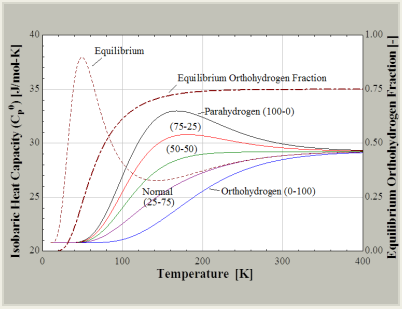
Completed Technology Project (2015 - 2015)

Project Introduction

The Hydrogen Properties for Energy Research (HYPER) laboratory at Washington State University (WSU) recently demonstrated a Cryocatalysis Hydrogen Experiment Facility (CHEF) to characterize parahydrogen-orthohydrogen catalysts for passive heat shielding. Current passive heat shields utilize boiloff vapors from liquid hydrogen (LH2) tanks to refrigerate and eliminate boiloff from liquid oxygen (LOX) tanks. Catalyzing the endothermic parahydrogen-orthohydrogen conversion is estimated to increase the refrigeration capacity of the hydrogen as much as 50% and effectively reduces the amount of hydrogen required to maintain zero boiloff of LOX. In this project, Ultramet will partner with the HYPER laboratory at WSU to synthesize, characterize, and compare ruthenium- and iron-based catalysts for optimal thermal properties and processing when applied to lightweight fiber blanket material for bulk application in passive heat shielding. In Phase I, a design matrix of catalysts will be characterized over a range of porosities and activities. Ultramet will perform surface area analysis of the catalyst granules prior to single-blind heat shielding tests in CHEF at the HYPER laboratory. In Phase II, the properties of the leading catalysts will be optimized for phase and porosity, the properties of the leading blanket material will be applied to a COMSOL modeling program already developed by the HYPER lab to design a prototype blanket, and a manufacturing plan will be developed. Potential Phase II and III teaming partners are United Launch Alliance (ULA) and Boeing, both of which have expressed interest in the technology.

Primary U.S. Work Locations and Key Partners





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Organizations Performing Work	Role	Type	Location
Ultramet	Lead Organization	Industry	Pacoima, California
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
California	Ohio

Project Transitions

June 2015: Project Start

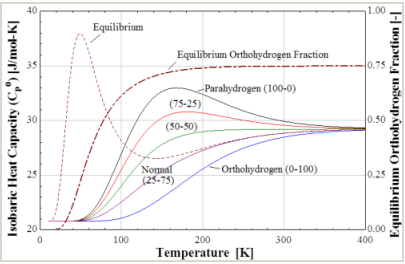
December 2015: Closed out

Closeout Summary: Parahydrogen-Orthohydrogen Catalytic Conversion for Cry ogenic Propellant Passive Heat Shielding, Phase I Project Image

Closeout Documentation:

- Final Summary Chart Image*(https://techport.nasa.gov/file/139318)*

Images



Briefing Chart Image
Parahydrogen-Orthohydrogen Catalytic Conversion for Cryogenic Propellant Passive Heat Shielding, Phase I
(https://techport.nasa.gov/image/136498)

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
Ultramet

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

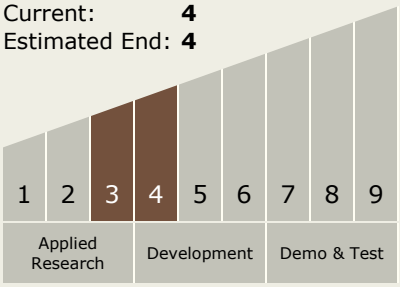
Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Matthew J Wright

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



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Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.3 Cryogenic

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System